

The Hohokam of Southern Arizona: Geologic Environment and Agriculture

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The Hohokam, their culture and agriculture:

Picture, if you will, a scene taking place in what is now Phoenix at some time between more than 4,000 years ago and 600 years ago: The twenty-five Hohokam elders slowly gather in the tribal meeting hall, a semi-subterranean mud-walled, mud and palm-thatched building with its floor recessed a yard below ground. The hall is at the east foot of what is now called Sentinel Peak or A-Mountain (Figure 1), just west of the Santa Cruz River in present-day Tucson, Arizona, in the surprisingly lush Sonoran Desert.

The elders meet this week to plan pre-summer monsoon planting, crop irrigation, community ball court games, harvests, hunting excursions, marriages and the supply of salt from Sonora and the Gulf of California as well as food, fiber and the management of water in their extensive irrigation systems (Figure 2 on page 5). The Hohokam supplement their primarily plant-food diet with meat. They have no domestic animals except the dog. Since they have no livestock (unlike some neighboring southwestern peoples, who have domesticated the turkey), meat is obtained by hunting and trapping. Deer and rabbit are important meat sources, but they also eat mountain sheep, antelope, mice and squirrels.

The tribal elders meet every year during the May full moon to focus on management of the upcoming summer monsoon. Each clan's elder represents a cluster of families eager to plant summer crops to take advantage of the semi-annual rains. The normal flows of the Santa Cruz, like the Gila and Salt Rivers to the north, provide nearly perennial fresh water, skimmed off by main, lateral and on-farm hand-dug earthen canals. The canals provide sustainable water for general family use and crop irrigation as they've done for hundreds, perhaps thousands, of years.

The earliest Spanish historical accounts, and geologic and hydrologic studies, indicate that the Santa Cruz

(Pre-)Historic preservation & forgery: The irrigation works of the Hohokam are threatened by urban development, but although there has been some unfortunate vandalism of Hohokam petroglyphs or "rock art," there is no record of fraud or fake Hohokam artifacts. However, in September 1924 lead crosses were "discovered" at an abandoned lime kiln site on Tucson's North Silverbell Road north of West Sunset Road (3 mi NW of NW corner of Figure 1), giving rise to a remarkably popular story that Romans had settled Arizona. The ruse was uncovered when it was noted the cross-engraved letters were copied from ancient texts, misspelled words included.

River only flowed perennially in about six locations along its total length. One of those perennial flows was in the San Xavier vicinity and another at the base of 'A' Mountain. Unfortunately,

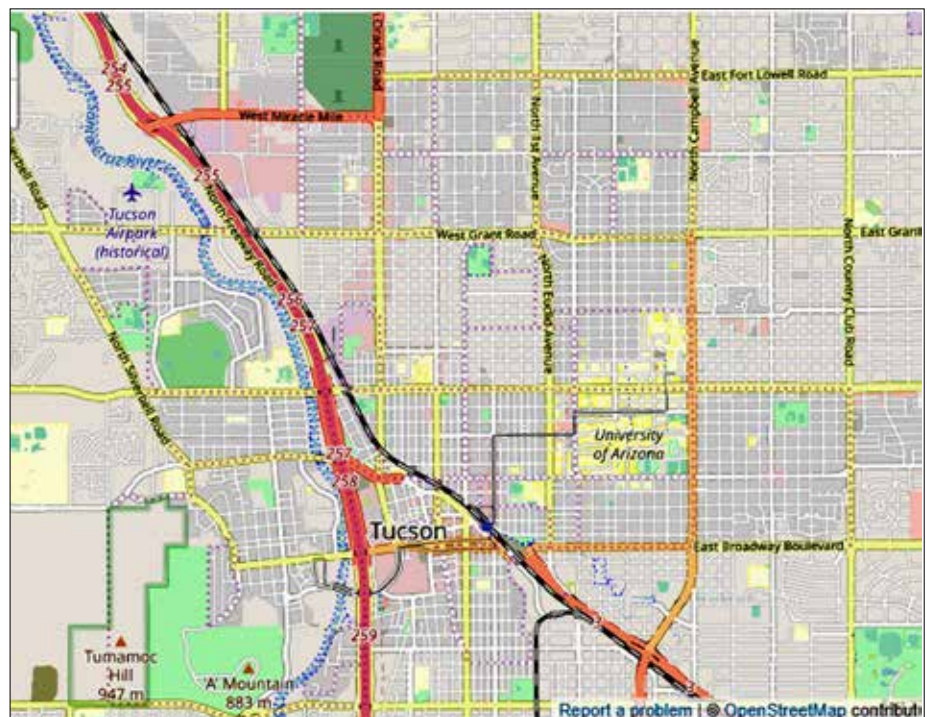


Figure 1. Tucson, AZ, location map showing places mentioned in text. 'A' Mountain is at bottom left. Image Source: Open Street Map.

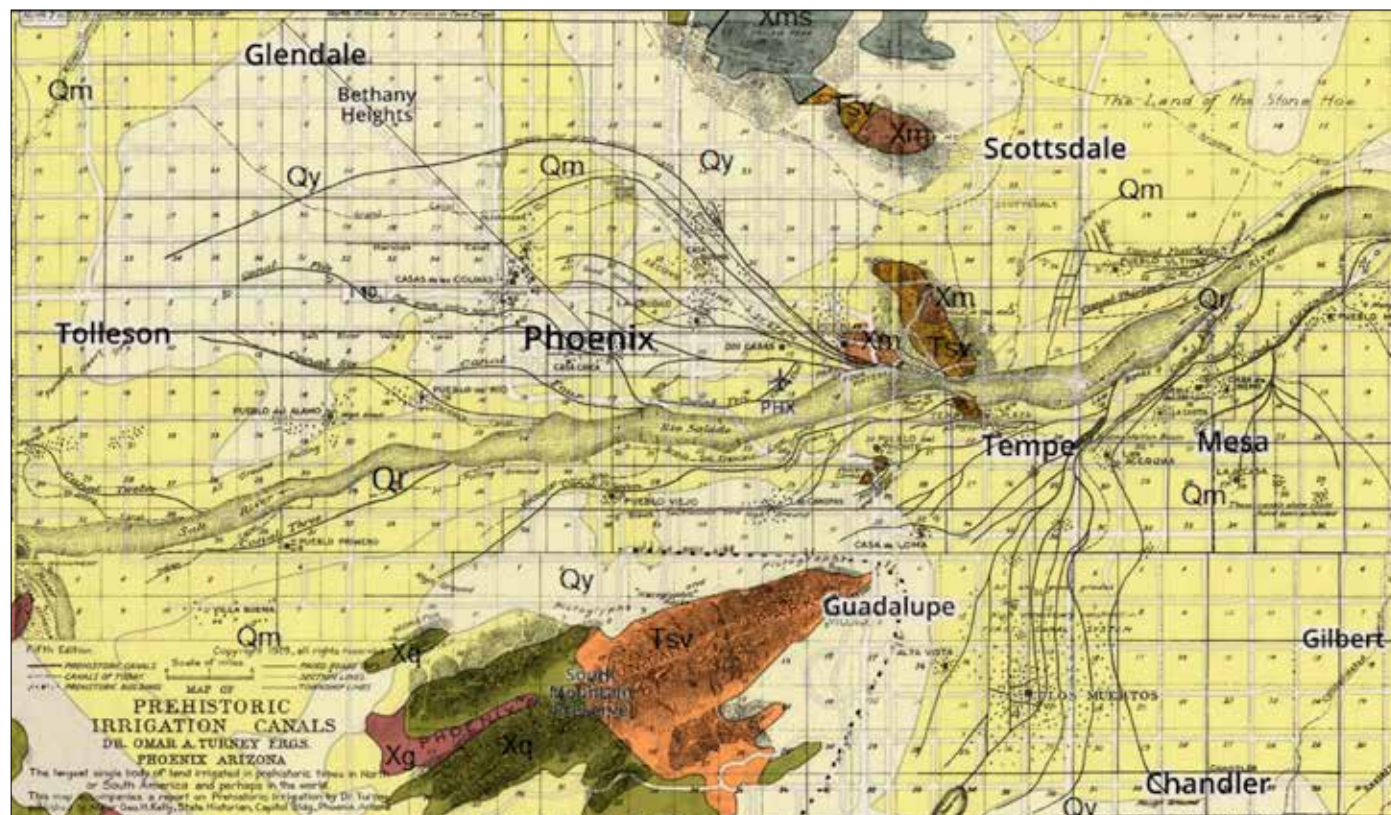


Figure 2. Phoenix Engineer Omar Turney's 1929 map of Hohokam canals in Salt River Valley, Arizona composited with the Geological Map covering the same area. Legend: Qr - Holocene river alluvium, Qy - Holocene surficial deposits (Alluvial plains, fans, etc.), Qm - Late Pleistocene surficial deposits (alluvial fans, etc., with soil development), Tsv- Oligo-Miocene interbedded volcanic and sediments, Xg – early Proterozoic granite, Xms – early Proterozoic metasediments, Xm – early Proterozoic metamorphic rocks, Xq – early Proterozoic quartzite. Note that the Hohokam canal-builders had a preference for older alluvium with soil development (Qm).

by the 19th century or our era, these rivers were no longer “alive” all year.

Most of these hand-dug earthen canals are no deeper than a man is tall, and less than the width of a person's outstretched arms. The Hohokam canals in the Tucson area range from less than a few hundred feet to a thousand feet long, whereas in the area around modern-day Phoenix, some of the 15 or so canals off the Salt River (see Figures 2 & 3) are eight times wider and twice as deep (Figure 4), because the soil there is easier to dig, and up to 20 miles long because the land is flatter. The over 500 miles of Phoenix-area canals are designed and constructed with a gradient of one to two feet per mile to sustain an erosion-safe flow velocity of about one to nearly three feet per second. They become narrower downgradient to maintain a nearly constant flow velocity. Consequently, the main canals when well-maintained may readily produce a base flow from shallow groundwater of about 25 to 75 acre-feet per day. The longest prehistoric canal identified along the Santa Cruz River (see Figure 2) is a 6.7-mile-long one that ran to the Marana Platform Mound site near the I-10 Marana Exit. The longest Hohokam canal known along the Salt River is about 27 miles long. Imagine the labor required to keep these canals alive, as they silt up quickly and need re-digging every other year or so. Only primitive hand tools made from stone, bones and trees, such as overhead-digging-sticks, were available for use - no metal drills, hoes, axes, hammers or shovels; no wheel barrows; no front-end loaders, backhoes or ditch-witches. No pulleys, gears or cables, and no theodolites or lasers, surveyor's levels, tapes or chains.



Figure 3. Extent of Hohokam occupation.
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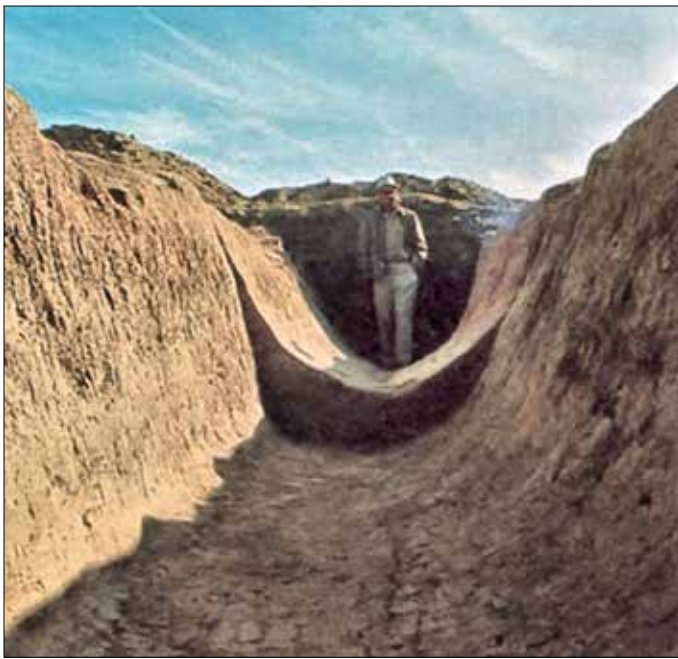


Figure 4. Archaeologist Emil “Doc” Haury in an Excavated Canal at Snaketown (S. of Phoenix) in 1964 (Rose 2014). The reddish color and its increase in intensity upwards suggest that this canal cuts an older alluvial fan with a well-developed soil profile. Image source: <http://waterhistory.org/histories/hohokam2>.

Before every monsoon season the canals had to be arduously maintained and repaired. This included the re-digging of silted-in canals and the replacement of worn out or damaged portable sluices, which were made of cloth or interwoven plant stalks, or simply piled rock. The perennial big question was “should the villagers try to bring more land under cultivation, or cut back to less?”

In the Phoenix area the base flow and the recurring winter and summer floods provided sufficient water for 50,000 to

From the Arizona State Museum, Paths of Life – American Indians of the Southwest and Mexico: “The world would burn without rain.” *Tohono O’odham wisdom*

The arrival of summer rains is a critical event that marks the beginning of the O’odham year. A Tohono O’odham legend relates the harvest of the saguaro fruit to the arrival of the rains.

Long ago, a dust devil attacked the daughter of a powerful man. Enraged, her father convinced his neighbors to drive the Wind away. But when the Wind departed, he took along his blind friend Rain. For four years, everything withered.

When they could stand the heat and thirst no more, the O’odham asked the Hummingbird to find Wind and Rain, and beg them to return. Tying some of his down on a stick, Hummingbird flew across the earth until he saw the down stir.

He found Wind and Rain in a cave. Wind said, “Tell our relatives that if they want us, they must sing for us for four nights. We’ll return when they finish the ceremony.”

Hummingbird returned to the O’odham with the Wind’s demand. The people decided that they needed to make the Wind forget their harsh words.

And so, they made nawait – saguaro wine.

The Three Sisters

According to Navajo legend, “The Three Sisters” is the combination of planted maize, squash and beans. The Three Sisters get along so well when they are planted together. The bean vines climb up the corn stalks for support, while the squash plants cover the ground below the beans. The large leaves of the squash plants keep out the weeds and shade the soil to keep it from drying out. Although corn plants have high nitrogen demand, bean plants are legumes and “fix” or remove nitrogen from the air and fix it in the soil, which helps to meet corn’s nitrogen demand.

80,000 Hohokam people (10,000 to 16,000 families) to use for drinking, washing, bathing, and crop irrigation, assuming that per person consumptive water use was a few gallons a day and crop-irrigation water consumptive use for corn (maize), cotton, tobacco and deep-rooted, beans, squash and peppers was a few feet per season. Crop acreages are estimated at over 100,000 acres.

But estimates made from captured base (groundwater-inflow) canal flows, and from consumptive domestic and irrigation water use, confirm that base-flow alone was insufficient to support the large population as well as the irrigated acreages indicated by the archaeological evidence. Therefore, by ancient tradition, the Hohokam prepared three times the amount of land that they expected that the farmers could normally irrigate and cultivate, so as to provide an opportunity to plant, produce, harvest and store more if the gods permitted.

Just about everyone in the villages was directly tied to community agriculture. Some families were more often successful than others because of their land’s fertility, their family’s size and ability, or their inherited secrets of crop pest and disease control, soil amendments and fertilization.

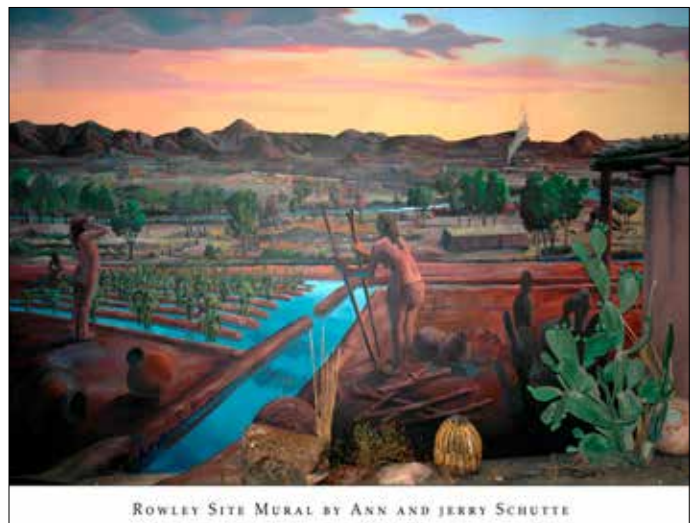


Figure 5. Mural in the Arizona Museum of Natural History of the Rowley Site, near Park of the Canals in Mesa, c. 1200-1450, by Ann and Jerry Schutte, showing typical Hohokam agricultural layouts (With permission of Arizona Museum Of Natural History).

Most of the farmed land was flood irrigated along short rows, small squares or rectangular flat plots by canals (Figure 5). Some was drip irrigated using large hollowed water-filled gourds. Crops were typically corn, beans, squash, melons, peppers, cotton and tobacco. Agave plants were also stand-alone common crops.

Crop pests and diseases were controlled by taking care not to over-irrigate or to allow standing water and humidity: this attracts insects and plant rot. Soil amendments were burnt crop residue and plant debris, including mesquite leaves which are natural pesticides. Fertilizers were stabilized human manure and heavily diluted human urine which, if not stabilized and diluted, would otherwise burn the crops.

Human wastes were collected: urine in clay pots and fecal matter in baskets for stabilization prior for use as natural crop fertilizers. Otherwise, the natural alluvial soils were very low in organic matter, nutrients and fertility. Because the natural soils were well-drained, clay and silt might have been added to improve their water-retaining capacities.

Much attention was given to scheduling planting, irrigating and harvesting. Harvested crops were stored in cool dry pots and kilns, to avoid moisture that attracts insects and vermin. Planning also focused on food preparation with adequate fresh water to aid digestion. All of this was achieved without metal tools or wheels, surveying or construction equipment, written language, maps and plot plans to record these practices or for future use. Thus, much depended on the wise memory of the elders.

Here in the Santa Cruz, from Black Mountain to Cañada del

How a young girl finds a suitable husband

According to a modified Pascua Tribe Yaqui legend, a young girl might pick a husband in this manner. She dreams herself to become an eagle and throws a branch into the sky hoping to attract a male eagle. When an engaging male eagle retrieves the branch, she throws a larger and heavier branch into the sky hoping to attract a stronger male eagle. In this way, through repetition, she finally decides to mate with the strongest eagle she can identify. Then, she dreams herself back to a human girl and her chosen strongest eagle into a human man to be her husband. In this way, she assures herself she will have a strong marriage, protected by a strong husband who will father her strong children.

Oro in the north, several thousand families lived in hundreds of clan settlements, each consisting of a few tens of families in extended family mud-walled, mud and palm-thatched-roofed, circular or oval recessed-pit adobes. Pit houses varied considerably in shape and size. They typically were circular with about 12-15 foot diameters for nuclear families or oval or rectangular at about 12-15 feet wide and 30-45 feet long with rounded corners for extended families. The clan leaders typically had larger houses with as many as 20 to 30 residents.

Although the people worked cooperatively in common and lived in sedentary villages, some were more productive and prosperous than others. The more prosperous families hired more labor from other families. They produced more excess food and fiber. They traded for a greater variety of foods: a large dependable supply of seawater foods including fish, crabs, clams, oysters and turtles from Bahia Adair and Estero de Morua on the Gulf of California and spices, and nuts, as well as cosmetics, perfumes, textiles, clothing, pottery, baskets, wine, jewelry, ball court seats, servants and of course wives. They may have been more generous than others.

Current anthropological and archeological thinking estimates that average adult Hohokam life spans were 30 to 40 years. Infant and child mortality was high due to childhood

A desert Southwest tale of cooperation

Every full moon, the animals would gather in an abandoned pit house to discuss the upcoming month. So many would want to attend uninvited that Coyote suggested they install a wooden gate made from occotea. One afternoon awaiting the full moon, Coyote, Eagle, Bluebird, Quail, Bear and Rattlesnake were disturbed by a thumping outside the gate. It was pesty cottontail Rabbit thumping on the gate to be allowed in. Coyote said, "Tell Rabbit to go away." Bear yelled in a deep voice, "Go away." It was quiet for a few minutes. But then, the thumping continued. Coyote said, "Throw some sand at Rabbit!" Bear picked up some sand from the pit house floor and threw it at Rabbit. In was quiet for a few minutes. But then again, the thumping returned. Finally, Coyote shouted, "Kill Rabbit!" Bear picked up a black-rock pointed spear and ran it through Rabbit. It was finally quiet for a few minutes. But yet again, the thumping returned. Finally, Coyote said, "Okay, let thumper Rabbit in the pit house." Bear opened the gate and Rabbit's thumping heart rolled into the house and was quiet.

diarrhea, malnutrition, dehydration, parasites, infections, poor medical care and lack of access to water.

The Hohokam and Geology:

All of the Hohokam territory lies within the Southern Basin and Range Province, in which crustal extension, related to changes in the subduction regime at the western margin of North America, has been approximately 100% since the early Miocene. The Phoenix and Tucson areas are less than 200 miles from the Gulf of California, thus enabling the Hohokam to trade with coastal communities for salt, dried fish and other commodities.

Crustal extension was accompanied by widespread volcanism and gave rise to linear ranges of fault-uplifted mountains between wide valleys, whose underlying grabens are filled with debris eroded from the mountains. Since it has been nearly 20 m.y. since these processes began in this part of the Basin and Range, both the mountains and the volcanic cover have been deeply eroded, exposing rocks as old as 1.8 billion years in the mountain cores. The volcanics, such as the 20-30 million-year-old andesite of Black Mountain in Tucson, and many of the ancient rocks are of mafic affinities. Soils derived from these rocks should be finer-grained, more clay- and nutrient-rich than the alluvial soils adjacent to the Salt, Gila and Santa Cruz Rivers, which are derived from the much older metamorphic rocks of surrounding and nearby mountains (Figure 2). However, no preference for these mafic-derived soils is apparent from the map of the canals (Figure 2). The alluvial soils, especially those on older alluvium that has been exposed to chemical weathering over a long period of time, were among the most suitable for Hohokam crop irrigation because they were generally flat, deep, well-drained and adjacent to the somewhat perennial or "live" streams. It is noticeable in the composite of Figure 2 that many of the Hohokam irrigation works in the Phoenix area are concentrated on these older alluvial deposits (Qm on the map), and Figure 4 illustrates the reddish tinge due to deep weathering.

Where did the Hohokam go?

Where did the Hohokam, "ancient people" or "someone who is all gone," go? Some say they died out from drought, disease, soil salinization, famine, warfare or internal social conflict.

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Some say the Tohono O'odham "desert people" of Southern Arizona are their descendants.

Repeated and long-lasting drought most likely lies at the root of the collapse of their society: studies of tree-rings carried out at the University of Arizona suggest that there were "mega-droughts" in the southwestern USA from 0-400 AD and from 1000-1400 AD (Routson (2014) and Figure 6)

Historically, until about the late 1700s, the O'odham who lived along the Santa Cruz were known as Sobaipuri ('fierce') and identified themselves as Akimel O'odham (River People) rather than Tohono O'odham (Desert People). Tohono O'odham from the desert areas farther west didn't begin moving into the Santa Cruz Valley till late 1700s to early 1800s after the Sobaipuri had been decimated by European diseases and warfare with Apache, Janos, Jocomé, and Manso groups.

Today, one can visit the Casa Grande Ruins National Monument, in Coolidge, Arizona, just northeast of the city of Casa Grande. This Monument preserves a group of Ancestral Puebloan Hohokam structures of the Pueblo III and Pueblo IV Eras. They have a marvelous gift shop. The best evidence for the canals is now preserved in old photographs in Arizona museums, publications, online websites, and occasional archaeological dig sites. Modern Phoenix farmers once readily

identified Hohokam canals and often mimicked their locations for their modern irrigation canal alignments. After the centuries of use by the Hohokam they could be recognized because they retained water and the surface soils over them were darker than the natural alluvial soils because they were more silty, clayey and organic-rich. Aerial photographs, land use maps, plot plans, and environmental assessments indicate that urbanization, energy and water utility networks, transportation corridors, and modern farming have erased much of the Hohokam irrigation systems from the Salt, Gila, and Santa Cruz River Basins.

Another noticeable thing is the way that the largest group of canals fans out from the area of the outcrops that constrict the river, forming a natural weir at high stages, just west of Tempe.

Furthermore, the Sonoran Desert in Southern Arizona is relatively lush because it has both winter and summer rainy seasons, with about 10 to 13 inches of annual rainfall in its southern alluvial valleys, and 4 to 10 inches in its northern valleys. The surrounding uplifted mountains receive nearly twice that amount. This means that the major rivers are perennial or almost so, as was the case of the Santa Cruz River below Centennial Peak ('A' Mountain) in Tucson before

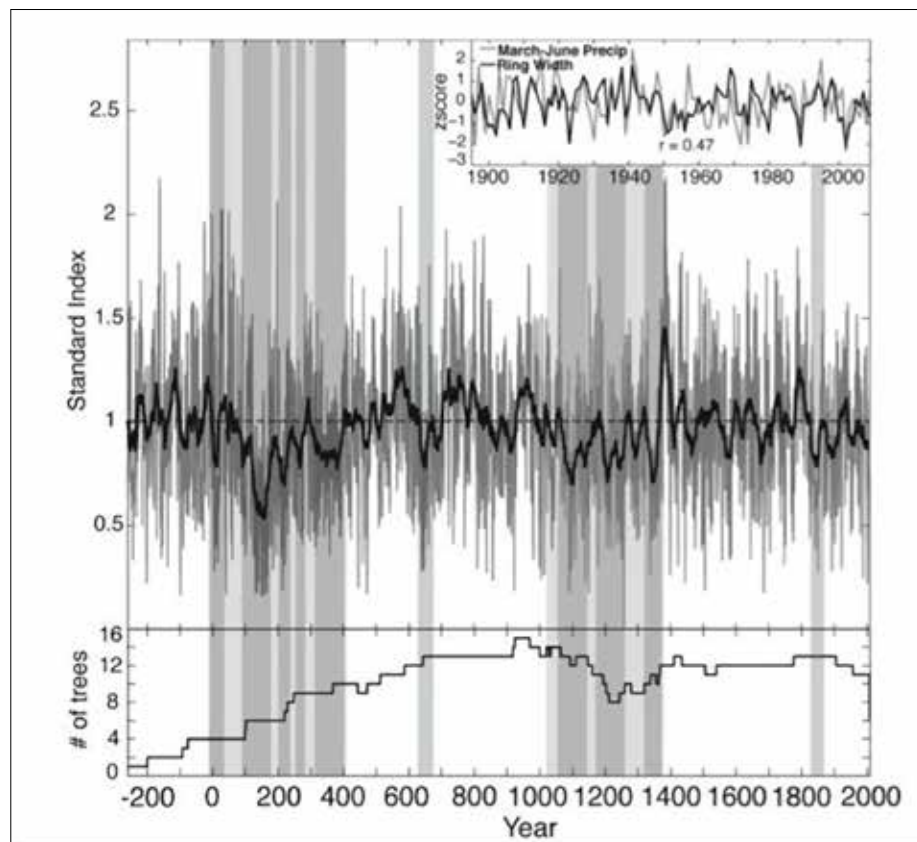


Figure 6. Summitville bristlecone chronology standard index (grey) smoothed with a 25-yr moving average (black) and number of trees (bottom). Narrow shaded bars are the 10 driest 25-yr periods defined by the Summitville chronology. Wide shaded bars highlight multicentury periods of increased aridity and drought frequency (Fig. 2 from Routson et al., 2011, with permission).

urbanization. However, the high potential annual evaporation, about 80 inches, puts stress on plants soon after each rainfall, thus requiring irrigation from the rivers to provide sufficient water for a full growing season.

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